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(71) Applicant(s)
BG plc
(Incorporated in the United Kingdom)
100 Thames Valley Park Drive, READING, Berkshire, RG6 1PT, United Kingdom

(72) Inventor(s)
Stuart Charles Murray

(74) Agent and/or Address for Service
BG plc
Intellectual Property Department, 100 Thames Valley Park Drive, READING, Berkshire, RG6 1PT, United Kingdom

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(56) Documents Cited
GB 2303444 A GB 1589251 A GB 1584219 A
GB 1237547 A WO 98/22806 A1 US 5218206 A

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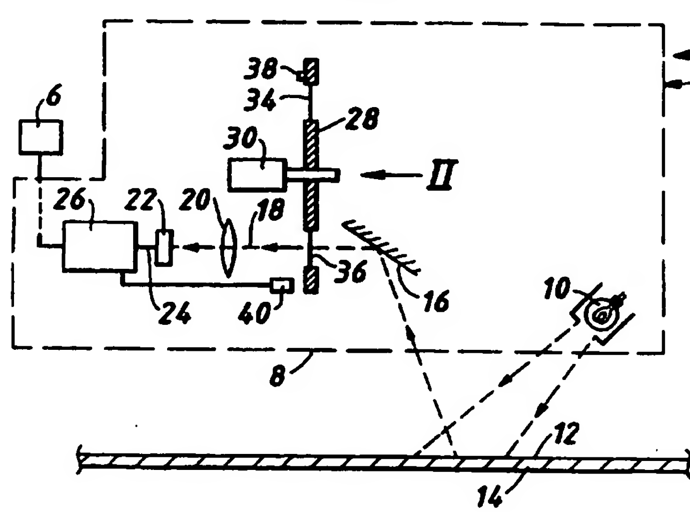
(54) Abstract Title

System to detect the presence of water on a surface

(57) In a system to detect the presence of water on surface 12 eg the wall of a pipe, the surface is illuminated by a source of infra-red radiation 10 including first and second wavelengths which are both absorbed by water but to different extents. Radiation is reflected off the surface 12 and is detected by sensor 22. A rotating chopper alternately introduces filters 34, 36 into the optical path which transmit either the first or the second wavelength respectively. When the measured intensity of one of the wavelengths varies in relation to that of the other water is determined to be present on the surface.

The two wavelengths are 1900nm and 2200nm with the 2200nm signal acting as a reference.

FIG.1.



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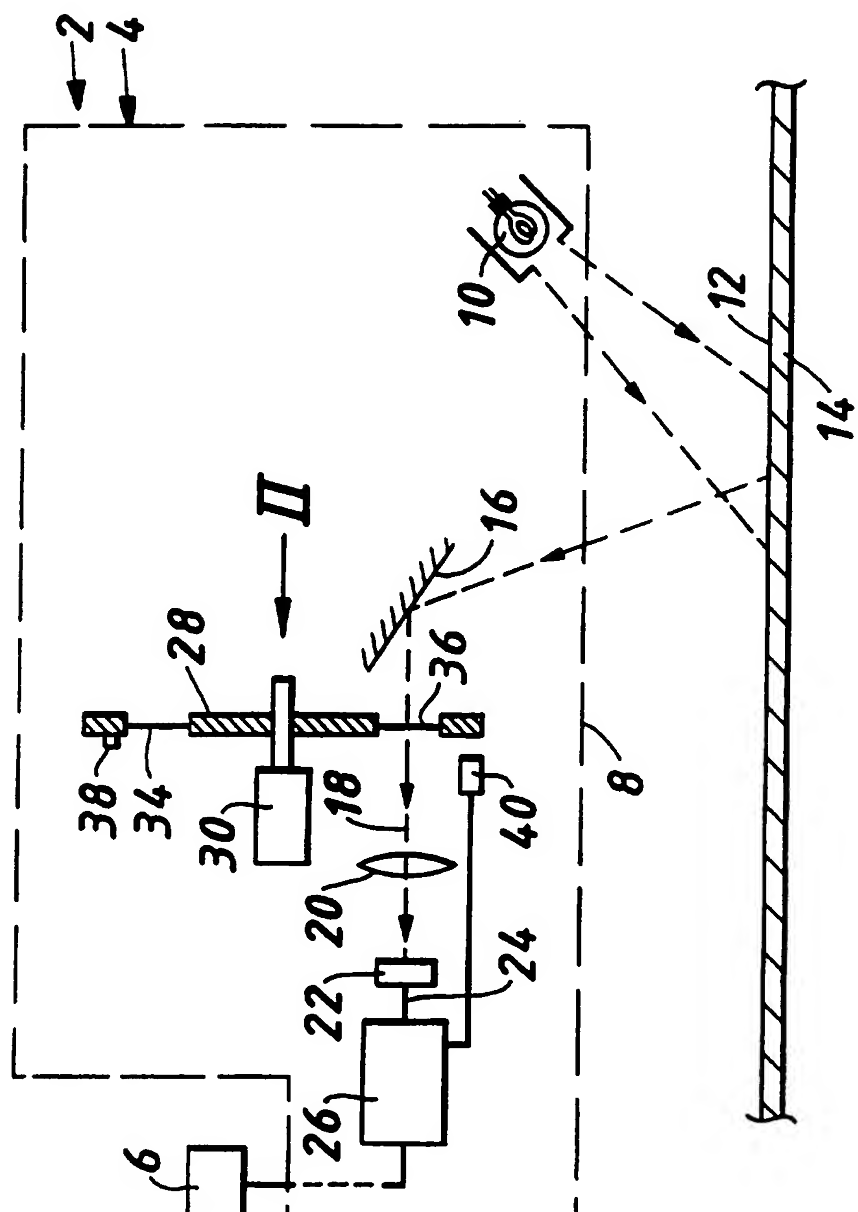


FIG.1.

FIG. 2.

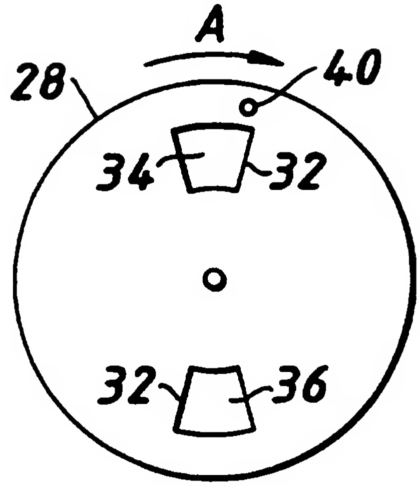


FIG. 3.

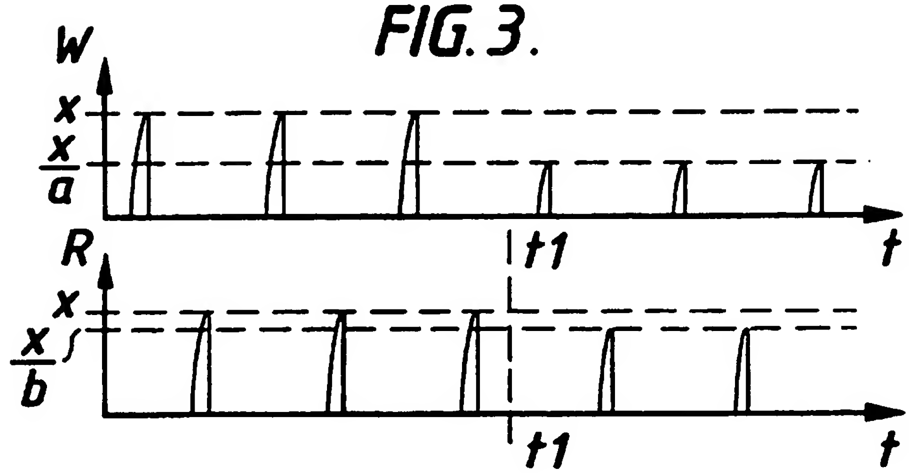
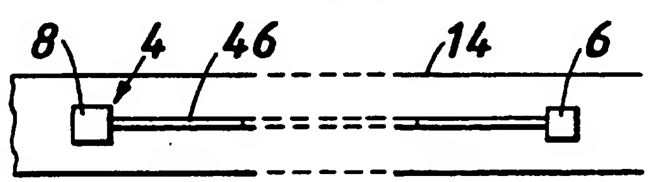


FIG. 4.



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Method And Apparatus To Detect The Presence Of Water On A Surface

This invention relates to a method and apparatus to detect the presence of water on a surface.

The method and apparatus may be used to detect the presence of water on an inside surface of a fuel gas main or pipe to indicate ingress of water into the main or pipe.

According to a first aspect of the invention a method of detecting the presence of water on a surface comprises emitting an optical signal comprising at least a first wavelength and a second wavelength, both said wavelengths being absorbed by water but said first wavelength being absorbed to a greater extent than said second wavelength so that said second wavelength provides a reference, directing said optical signal onto a said surface from which the signal is reflected, alternately passing the reflected signal through a first optical filter which passes substantially only an optical signal of said first wavelength and through a second optical filter which passes substantially only an optical signal of said second wavelength, and observing when the strength of a signal emergent from the first optical filter differs in a pre-determined way from the strength of the reference passed by the second optical filter to indicate the presence of water on the surface.

According to a second aspect of the invention apparatus to detect the presence of water on a surface comprises an optical source to emit an optical signal comprising at least a first wavelength and a second wavelength, both said wavelengths being absorbed by water but said first wavelength being absorbed to a greater extent than said second wavelength so that said second wavelength provides a reference, means to direct said optical signal onto a said surface for reflection thereby, a first optical filter which passes only an optical signal of said first wavelength, a second optical filter which passes only an optical signal of said second wavelength, means to interpose alternately the first optical filter and the second optical filter in the path of the reflected optical signal, and means to observe when the strength of a signal emergent from the first optical filter differs in a pre-determined way from the strength of the reference passed by the second optical filter to indicate the presence of water on the surface.

Each aspect of the invention will now be further described, by way of example, with reference to the accompanying drawing in which:-

Fig.1 is a diagrammatic representation, partly in section, of an apparatus formed according to the second aspect of the invention for carrying out the method according to the first aspect of the invention;

Fig.2 is a fragmentary view of the apparatus in Fig.1 along the arrow II;

Fig.3 is a diagrammatic representation of strengths of optical signals transmitted through the first optical filter and the second optical filter of the apparatus in Fig. 1, and

Fig.4 is a diagrammatic representation of how the apparatus in Fig. 1 may be arranged for inspecting an interior of a pipe for the presence of water.

With reference to Fig.1 an apparatus 2 to detect the presence of water on a surface, for example an internal surface of, for example, a pipe or main which may convey gas, for example, fuel gas, has a detection unit 4 and an indicator 6. The detection unit 4 mounted within a common casing 8, shown in dotted lines, comprises an optical source 10 to emit an optical signal in the infra-red wave band. For example, the source 10 may be a filament lamp bulb. The optical signal includes infra-red wavelengths which are absorbed by water, but some of those infra-red wave lengths are absorbed by water to a greater extent than others of those infra-red wavelengths. The arrangement is such that the emitted infra-red signal is reflected (diffusely reflected) by a surface 12, for example an inner surface of a pipe wall 14 onto a mirror or other reflector 16 so disposed that it can only receive a reflected signal and not one direct from the source 10. From reflector 16 the reflected signal follows a path 18 through a

focusing lens arrangement 20 and imaged onto an infra-red detector 22, which may be a lead-sulphide type, which generates an electrical signal on line 24 representative of the strength or intensity of the infra-red signal incident on the detector 22. The signal on line 24 is input to an electronic control 26.

Interposed in the reflected signal path 18 is a chopper 28 which is rotated by an electric motor 30, for example a stepper motor, and comprises, as shown in Fig. 2, a disc formed with two diametrically opposed openings or windows 32 one occupied by an optical filter 34 and the other occupied by an optical filter 36. Filter 34 only passes certain infra-red wavelengths and filter 36 only passes certain other infra-red wavelengths. All those infra-red wavelengths are absorbed by water but those passed by the filter 34 are absorbed by water to a greater extent than those passed by the filter 36. The infra-red wavelengths passed by the filter 34 have a wavelength of substantially 1900nm, (nanometres). The signal passed by the filter 34 is hereinafter called "the water observation signal". The infra-red wavelengths passed by the filter 36 (and absorbed by water to a lesser extent than the water observation signal) serve as a reference signal. The infra-red wavelength passed by the filter 36 may be substantially 2200 nm. An infra-red signal having a wavelength of substantially 2200 nm is not absorbed by water nor by ethylene glycol (which is added to natural gas in the United Kingdom to maintain the effectiveness of gas tight

seals used on fitting connected to gas mains) to the same extent as a signal of 1900 nm wavelength.

As the chopper 28 is rotated (in direction A in Fig. 2), the optical filter 34 is interposed in signal path 18 for a short time and then after a somewhat longer period the optical filter 36 is interposed in the path 18 for a time similar to that for the filter 34. The strength or intensity of the water observation signal when not absorbed by water may be substantially the same as that of the reference signal. Accordingly, when water is not present, the detector 22 responds to the water observation and reference signals substantially similarly and gives substantially the same output signal on line 24. So that control 26 can identify which signal, reference or water observation signal, is being observed by the detector 22 a marker 38 corresponding to the optical filter 34 is provided to which sensor 40 is arranged to respond. When the marker 38 passes the sensor 40 the control 26 receives a signal from that sensor indicating that the signal the control is receiving from the detector 22 corresponds to the water observing signal whereby the control 26 understands that the next signal it receives from the detector 22 corresponds to the reference signal. Thus the control 26 can distinguish between the water observation signal and the reference signal.

The control 26 observes the strength or intensity of the water observation signal and the reference signal in turn and

repeatedly. The observed value of the reference signal is divided in the control 26 by the observed value of the water observation signal, and the quotient is substantially unity when water is not present. But the quotient is greater than unity when water is present to reduce the value of the detected water observation siganl by absorption of at least some of that signal by the water. When the quotient exceeds the value of the water observation signal, the control 26 sends a signal to the indicator 6 to provide an indication that the presence of water is detected.

Fig. 3 shows variation in the strength W of water observation signals with respect to time t received by the detector 22 and over the same time-frame variation in the strength R of signals with respect to the time t received by the detector. Initially, the values of W and R are the same, namely x so that $\frac{x}{x} = 1$ or unity signifying an an absence of water.

But at a time t1 and thereafter the value of W falls to $\frac{x}{a}$ where a is a number greater than 1, and the value of R falls to $\frac{x}{b}$ where b is a number less than a so that $\frac{\frac{x}{b}}{\frac{x}{a}} = \frac{a}{b}$

which exceeds unity signifying the presence of water.

The chopper 28 may be driven at any speed, but the faster it rotates the greater the resolution.

The use of a reference signal as a comparison means that the response of the apparatus water is not affected by variation in the reflecting properties of the surface 12 or if there is displacement of apparatus parts relative to one another, since both the reference signal and the water observation signal are each affected equally.

The apparatus 2 can be moved relative to the surface 12 to observe for the presence of water at different places on the surface.

In Fig. 4 the detection unit 4 is shown being moved along the interior of the pipe 14 on an extensible or telescopic support or arm 46 carrying the indicator 6 at the other end.

Claims

1. A method of detecting the presence of water on a surface comprising emitting an optical signal comprising at least a first wavelength and a second wavelength, both said wavelengths being absorbed by water but said first wavelength being absorbed to a greater extent than said second wavelength so that said second wavelength provides a reference, directing said optical signal onto a said surface from which the signal is reflected, alternately passing the reflected signal through a first optical filter which passes substantially only an optical signal of said first wavelength and through a second optical filter which passes substantially only an optical signal of said second wavelength, and observing when the strength of a signal emergent from the first optical filter differs in a pre-determined way from the strength of the reference passed by the second optical filter to indicate the presence of water on the surface.

2. A method as claimed in Claim 1, in which the optical signal is an infra-red signal.

3. A method as claimed in Claim 1 or Claim 2, in which the first and second optical filter are rotated.

4. A method as claimed in Claim 2, or in Claim 3 when dependant from Claim 2, in which the first optical filter

substantially passes an infra-red signal having a wavelength of substantially 1900 nm.

5. A method as claimed in Claim 2 or Claim 4, or in Claim 3 when dependant from Claim 2, in which the second optical filter substantially only passes an infra-red signal having a wavelength of substantially 2200 nm.

6. A method of detecting the presence of water on a surface substantially as hereinbefore described with reference to Figs. 1, 2 and 3 or Figs. 1, 2, 3 and 4 of the accompanying drawing.

7. Apparatus to detect the presence of water on a surface comprising an optical source to emit an optical signal comprising at least a first wavelength and a second wavelength both said wavelengths being absorbed by water but said first wavelength being absorbed to a greater extent than said second wavelength so that said second wavelength provides a reference, means to direct said optical signal onto a said surface for reflection thereby, a first optical filter which passes only an optical signal of said first wavelength, a second optical filter which passes only an optical signal of said second wavelength, means to interpose alternately the first optical filter and the second optical filter in a path of the reflected optical signal, and means to observe when the strength of a signal emergent from the first optical filter differs in a pre-determined way from the strength of the

reference passed by the second optical filter to indicate the presence of water on the surface.

8. An apparatus as claimed in Claim 7, in which the optical source is a source of infra-red radiation.

9. An apparatus as claimed in Claim 7 or Claim 8, which the first and second optical filters are rotatable.

10. An apparatus as claimed in Claim 9, in which the first and second optical filters are mounted on a chopper.

11. An apparatus as claimed in Claim 8, or in Claim 9 or Claim 10 when either is dependent from Claim 8, in which the first optical filter substantially only passes an infra-red signal having a wavelength of substantially 1900nm and/or the second optical filter substantially only passes an infra-red signal having a wavelength of substantially 2200 nm.

12. An apparatus as claimed in any one of Claim 7 to 11, in which said optical source, said optical filters and said means to observe are all mounted on a support for moving the optical source, the optical filters and the means to observe along an interior of a conduit or pipe.

13. An apparatus as claimed in Claim 12, in which said support comprises an extensible arm.

14. An apparatus to detect the presence of water on a surface, substantially as hereinbefore described with reference to Figs. 1, 2 and 3 or Figs. 1, 2, 3 and 4 of the accompanying drawing.

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Claims searched:	1,7	**Date of search:**	29 March 1999

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): G1A (ACDL, AMP, AMN, AMQX, ARN)

Int Cl (Ed.6): G01J 3/08, 3/42 & 3/427;
G01N 21/25, 21/27, 21/31, 21/35 & 33/18;
G08B 19/02 & 21/00

Other: ONLINE:- WPI, INSPEC, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage			Relevant to claims
Y	GB 2303444 A	(PROTIMETER)	See page 3 paragraph 2 for example	1-3 & 7-10
Y	GB 1589251	(SENTROL)	See whole document	1-3 & 7-10
Y	GB 1584219	(I.N.C)	See whole document	1-3 & 7-10
Y	GB 1237547	(STC)	See whole document	1-3 & 7-10
X,P	WO 98/22806 A1	(INFRARED ENG. LTD) See fig 2		1-3 & 7-10
Y	US 5218206	(SCHMITT)	See col 6 lines 6-11 in particular	1-3 & 7-10

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
		E	Patent document published on or after, but with priority date earlier than, the filing date of this application.
&	Member of the same patent family		